



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**THE AGILE RAPID GLOBAL COMBAT SUPPORT
(ARGCS) SYSTEM: A COST AND BENEFIT ANALYSIS
OF INCLUDING THE ARGCS TECHNOLOGIES IN THE
ACQUISITION OF THE ENHANCED CONSOLIDATED
SUPPORT SYSTEM (ECASS)**

by

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December 2007

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TECHNOLOGIES IN THE ACQUISITION OF THE ENHANCED
CONSOLIDATED SUPPORT SYSTEM (ECASS)**

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ABSTRACT

The purpose of this project is to provide a final business case analysis of the technologies demonstrated in the Agile Rapid Global Combat Support (ARGCS) system. Three theses and one professional paper have previously analyzed the ARGCS Advanced Concept Technology Demonstration (ACTD) return on (proposed) investment. This project will review those works, provide a history of the ARGCS ACTD, discuss the goals for the ACTD and compare alternatives. In particular, this analysis builds on previous efforts, including the Discrete-Event Simulation Model developed in the Bello, Rios, Carpenter thesis (December 2006).

The ultimate goal of this project is to assist in the analysis of the ARGCS technologies and what benefit they would provide if included in the proposed next generation of Naval Aviation test equipment, currently called the Enhanced Consolidated Automated Support System (ECASS).

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LIST OF ABBREVIATIONS AND ACRONYMS

ACTD	Advance Concept Technical Demonstration
ADSR	ARGCS Distance Support and Response
AIMD	Aircraft Intermediate Maintenance Department
ARGCS	Agile Rapid Global Combat Support
ATE	Automatic Test Equipment
ATS	Automatic Test System
BCA	Business Case Analysis
BIT	Built-in Test
CASS	Consolidated Automated Support System
CBA	Cost Benefit Analysis
COI	Critical Operational Issues
DAU	Defense Acquisition University
FMC	Full Mission Capable
FRC	Fleet Readiness Center
GDS	Global Database Server
GCCS	Global Command and Control System
I-Level	Intermediate Level
JITC	Joint Interoperability Test Command
JMUA	Joint Military Utility Assessment
JWP	Joint Warfighter Problem
LMS	Local Maintenance Server
LMUA	Limited Military Utility Assessment
LRIP	Limited Rate Initial Production
MTBF	Mean Time Between Failures
MOE	Measure of Effectiveness
MOP	Measure of Performance
MOS	Measure of Suitability
NAS	Naval Air Station

NAVAIR	Naval Air Systems Command
NMCI	Navy Marine Corps Internet
O-Level	Organizational Level
OSD	Office of the Secretary of Defense
USPACOM	United States Pacific Command
RMOS	Reasoner Model Optimizer Server
TETS	Third Echelon Test Set
TPS	Test Program Set
WRA	Weapons Replaceable Assembly

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I. INTRODUCTION

A. PURPOSE

The purpose of this project is to provide a final business case analysis of the technologies demonstrated in the Agile Rapid Global Combat Support (ARGCS) system. Three theses (1. Crosby, David, “Business Case Analysis: Agile Rapid Global Combat Support. 2. Jupiter, David L., Reuter, Lisa J., “The Development of a Business Case Analysis for the acquisition of the Agile Rapid Global Combat Support System used for the United States Marine Corps’ Ground Equipment.” 3. Bello, Brian, “Analysis of Agile Rapid Global Combat Support System Technologies in the support of the F/A-18C”) and one professional paper (Franck, Raymond, “Agile Rapid Global Combat Support, Business Case Analysis, Version 1.0) have previously analyzed the ARGCS Advanced Concept Technology Demonstration (ACTD) return on (proposed) investment. This project will review those works, provide a history of the ARGCS ACTD, discuss the technology developed in the ARGCS project, the goals for the ACTD and compare alternatives. In particular this analysis builds on previous efforts, including the Discrete-Event Simulation Model developed in the Bello, Rios, Carpenter thesis (December 2006).

The purpose of this project is to assist the Department of Defense in its analysis of ARGCS technologies and what benefit they would provide if included in the next generation of Naval Aviation test equipment, currently called the Enhanced Consolidated Automated Support System (ECASS).

B. RESEARCH QUESTIONS

This ARGCS analysis will focus on identifying benefits associated with the technologies included in the ACTD. The following questions will be the concentration of this thesis:

1. Primary Questions

1. What is ARGCS? What capability gaps does ARGCS address?
2. What are the ARGCS ACTDs, how do they interface with CASS and ECASS?
3. What is a BCA? How will this address the ROI of ARCS?
4. What is the best estimate of the ARGCS ROI based on the notional ECASS system?

2. Secondary Questions

1. What is the ARGCS program history and structure?
2. What is the nature of the test program?
3. What are the ARGCS prototypes and to what specifications were they built?
4. What are the resource impact areas (costs/savings)? To what extent can they be quantified?

C. BACKGROUND

In the mid 1980s, the U.S. Navy became the first Service to consolidate current Automated Test Systems (ATS) into a common-consolidated system of Automated Test Equipment (ATE) with a view toward reducing support costs. The first result of those efforts was the Consolidated Automatic Support System (CASS). Considered the largest automated test support program and the first recognized U.S Department of Defense (DoD) standard test system, CASS provides general-purpose analog and digital test capabilities. In 2004 Naval Air Systems Command's (NAVAIR) Program Management Activity (PMA) office received permission from The Joint Requirements Oversight Council (JROC) to begin the CASS modernization program, the titled the enhanced Consolidated Automatic Support System (ECASS).

In 2005, the Naval Postgraduate School (NPS) was approached by NAVAIR and OSD to participate in the analysis of the ARGCS technologies. The first project established by NPS was a thesis authored by CDR David Crosby in June 2006. The

thesis entitled “Development of a Business Case Analysis for the Acquisition of the Agile Rapid Global Combat Support System,” focused on the economic potential of the ARGCS system. This project was initiated with the goal to build a business case model to assess the potential savings if the next generation of Naval Aviation test equipment were augmented with the ARGCS system and produce an actual cost/benefit analysis. The benefits to be evaluated in this thesis included cost savings, efficiency improvements, as well as non-monetary readiness benefits obtained through better failure rates prediction and maintenance diagnostics. In the absence of test data, a framework baseline analysis was conducted using tools such as a Return on Investment (ROI), establishment of expected Net Present Value (NPV) and Internal Rate of Return (IRR), Manpower Sustainment calculations and a Sensitivity Analysis. As a result of ARGCS testing being delayed, less than 25 percent of the costs associated with ARGCS were known to any degree of certainty. As a result the project was modified to produce a model for application when further data became available. The results of the project recommended that a revised Business Case Analysis (BCA) be conducted at the conclusion of the ACTD testing.

The second project conducted by NPS in support of the ARGCS evaluation was a thesis by Lisa Jupiter and David Reuter, “The Development of a Business Case Analysis for the Acquisition of the Agile Rapid Global Combat Support System to be used for Marine Corps Ground Equipment (2006).” This project analyzed ARGCS technologies and used BCA methodology to determine the advisability for the USMC to incorporate ARGCS technologies in the proposed ATS replacement instead of the Third Generation Test System (TETS) that was introduced to the field in FY-2000. This thesis was also limited by lack of data. Nevertheless, this thesis provided a useful assessment of second-generation USMC test equipment and an excellent assessment of the virtues of the new TETS. It also provided the necessary groundwork for comparing ARGCS with TETS in increased operational availability of land combat weapons systems.

The third project conducted by NPS in support of the ARGCS evaluation was a thesis authored in December of 2006 by Alfred P. Bello III, Frankie Rios and Robert B. Carpenter, “Discrete-Event Simulation Modeling of the Repairable Inventory Process to

Enhance the ARGCS Business Case Analysis.” This project used a simulation model, with pre-existing maintenance and supply data to more accurately estimate maintenance and/or supply cost benefits from fielding ARGCS technologies. The results of the initial run of the simulation model indicated an increase in operational availability as well as cost savings.

The latest project completed at NPS assessing the value of the ARGCS system was an interim Business Case Analysis authored by Professor Raymond Franck and Carmelita Troy in January 2007. Revised in May of 2007, this interim BCA, based on the data then available, offered an assessment of the Return on Investment from the ARGCS ACTD and recommended a more definitive BCA at the conclusion of the ARGCS tests. This project provided an excellent framework for a thorough analysis of the ROI of ARGCS, cost savings related to the potential reduction in False Pulls associated with the technologies and how this reduction can increase Operational Availability of the F/A-18C and potentially reduce the number of aircraft required in the fleet.

Each of these projects enhances the formulation for a final BCA to include an updated Discrete-Event simulation using data obtained from the Limited Military Utility Assessment (LMUA) at Naval Air Station (NAS) Lemoore in August of 2007.

D. BACKGROUND ON THE FUNDING FOR THE ARGCS ACTD

As referenced earlier, the Navy received permission from the JROC in FY 2004 to develop a replacement ATS for CASS, the replacement system, ECASS is set to start Limited Rate Initial Production (LRIP) in FY 2012. This system targets updating relatively old test equipment, and upgrading test capabilities to support future weapons systems.”¹ In line with this initiative, the DoD’s Automatic Test Systems Management Board “launched ARGCS to bring about the development of a single tester that takes

¹ Courtney E. Howard, Military & Aerospace Electronics, “Attention turns to RF and microwave test and measurement,” May 2007.

advantage of an open-architecture system of modular hardware and flexible software to test and maintain combat systems across all branches of the U.S. Military.”²

OSD RTD&E Project P648 announced the ARGCS project, with the following guidance:

The Joint Requirements Oversight Council (JROC) validated the capability need for ARGCS as an FY-04 start which is using advanced technologies to demonstrate a family of testers for electronic components and provide unprecedented interoperability between weapon systems, Services, and levels of maintenance. This will reduce costs and the proliferation of testers while improving the availability and performance of weapons systems. In addition, ARGCS will demonstrate technologies to facilitate net-centric diagnostics by capturing historical logistics data and developing an expert support system that will further reduce repair times and costs, as well as future sparing requirements. Outputs and efficiencies will include increases in performance and test accuracy, interoperability between Services, reduced logistics and weapons system support costs, and reduced proliferation of automatic test systems in the future. (100% interoperability, Time to field – on year or less, 40% reduced time to diagnose and repair, proliferation of systems – reduced footprint by 50%, Scalability of systems – 100%). The ARGCS technology will be transitioned to the Services through existing automated test programs of record. The user sponsor is the U.S. Pacific Command and the lead service is the Navy.

FY 2008 planned output: Complete the ACTD and continue to evaluate ARGCS military utility through the EUE. Support transitions of ARGCS technologies and products into service programs of record.³

Also from a recent United States Pacific Command (USPACOM) “White Paper”:

Utilizing existing Services’ infrastructure and interfacing to the Services’ current logistic systems, ARGCS will provide the warfighter the ability to access SMEs to assist in maintenance actions in the field. It also provides the infrastructure to link all major data repositories, which provides all warfighters with the most up-to-date logistics, historical and training information in order to ensure the shortest test times and the most accurate fault diagnosis. Net-centric diagnostics electronically integrates test

² Howard, Military & Aerospace Electronics.

³ OSD RDT&E Justification (R2a Exhibit), Joint Capability Technology Demonstrations, Project P648, February 2007.

information across all test levels and at all locations, providing flexible interoperability. Historical maintenance and logistics data is stored and made available to users at all levels of maintenance, providing global connectivity.⁴

The industry focus for ARGCS and ECASS is inline with the restructuring initiatives of the Defense Advanced Research Projects Agency (DARPA) and the acquisition guidelines set forth in the DoD Joint Capabilities Integration Development System (JCIDS) instruction 5000.2. The Navy has traditionally sought bids from a number of contractors, in the case of CASS, “Boeing won the right to develop CASS after competing against Grumman and Lockheed in 1987,”⁵ In the case of ARGCS, in September of 2004, Northrop Grumman was awarded a \$26.7M contract to develop the ARGCS ACTD prototypes.⁶

E. SCOPE AND METHODOLOGY

The scope of this project will include: (1) a background on the ARGCS system, (2) a methodology of the research and a review of the process used in a BCA, (3) an analysis (methodology and content) of the LMUA and JMUA testing procedures data, and (4) A final BCA using an analysis of alternatives using existing cost information associated with CASS and an updated simulation using the model developed in the Bello et al., project.

The methodology used in this thesis research will consist of the following steps.

1. Conduct a literature search for background on the technologies used in the development of ARGCS in magazine articles, JITC discussions, NPS theses and other library information resources.
2. Conduct a comparison of BCA methodology and requirements, between that used by the Defense Acquisition University (DAU) and that preferred by civilian enterprise.
3. Conduct a review of the current ARGCS

⁴ White Paper.

⁵ CASS website: www.acq.osd.mil/ats/cass.htm

⁶ Northrop Grumman News Release, September 2004

4. A discussion of emergent technologies with the ARGCS ACTD.
5. A review of the current CASS equipment and an explanation of how the list of expectations for the ARGCS technologies was generated.
6. A review of the JROC requirements for the ARGCS testing and development.
7. A summary of major cost assumptions associated with the proposed development of ECASS.
8. An analysis of the potential for reduced “false pulls” and increased operational availability of the F/A-18 C due to the implementation of the ARGCS technologies.
9. An analysis of the two existing alternatives; keep CASS in-service until all technologies included in ARGCS have been fully evaluated or proceed with ECASS incorporating the proposed ARGCS technologies.

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II. DISCUSSION OF EXISTING TECHNOLOGIES USED IN THE ARGCS SYSTEM

A. ARGCS TECHNOLOGIES

Due to aging systems and rising O&M costs, new technologies have been researched and included in the ARGCS prototypes. The goal is to demonstrate several functional capabilities that will enhance Navy aircraft maintenance operations.⁷ Toward that effort ARGCS incorporates very modern, but proven, capabilities to improve test analysis over the existing system; the most significant are Open Systems Architecture, a Dual-Core processor and Synthetic instrumentation. The ARGCS ACTD demonstrated an open-architecture and upgradeable Radio Frequency (RF) test subsystem based on Synthetic Instruments.⁸

This portion of the research will lay out a basic explanation of these technologies.

B. OPEN SYSTEM ARCHITECTURE

Open systems architecture is a standard that describes the layered hierarchical structure of the systems overall design, which provides the following⁹:

- Enables system design, development, installation, operation, improvement, and maintenance to be performed at a given layer or layers in the hierarchical structure
- Allows each layer to provide a set of accessible functions that can be controlled and used by the functions in the layer above it
- Enables each layer to be implemented without affecting the implementation of other layers
- Allows the alteration of system performance by the modification of one or more layers without altering the existing equipment, procedures, and protocols at the remaining layers

⁷“Agile Rapid Global Combat Support Advanced Concept Technology Demonstration Integrated Assessment Plan” Joint Interoperability Test Command, FT Huachuca, AZ, May 2006.

⁸ARGCS ACTD White Paper.

⁹Carnegie Mellon University, Software Engineering Institute Website.

C. DUAL CORE PROCESSORS

A dual-core Central Processing Unit (CPU) combines two independent cores into a single package composed of a single integrated circuit.¹⁰

The proximity of dual multiple CPU cores on the same chip allows the circuitry to operate at a much higher clock rate than is possible if the signals have to travel off-chip. Combining equivalent CPUs on a single chip significantly improves the performance of operations. Put simply, this means that signals between different CPUs travel shorter distances, and therefore those signals degrade less. These higher quality signals allow more data to be sent in a given time period since individual signals can be shorter and do not need to be repeated as often.¹¹

Assuming that the chip can fit into the package, physically, the multi-core CPU designs require much less Printed Circuit Board (PCB) space than multi-chip designs. Also, a dual-core processor uses slightly less power than two coupled single-core processors, principally because of the increased power required to drive signals external to the chip and because the smaller silicon process geometry allows the cores to operate at lower voltages.¹²

Simply stated the improved capability of the CPU in ARGCS will allow much faster TPS times as the TPS technology improves to match up with the newer CPU technology.

D. SYNTHETIC INSTRUMENTATION

The term “synthetic instrumentation (SI)” was coined by the U.S. Department of Defense’s Next Generation Automatic Test Systems (NxTest) Integrated Product Team (IPT) to describe a new test architecture that would support the charter of its group. In April 2002, the DoD Automatic Test Systems (ATS) established the NxTest IPT with two

¹⁰Ichronic Website.

¹¹Ibid.

¹²RFDesign Website.

main goals: to reduce the total acquisition and support costs of DoD ATS and to improve the inter-operability of the armed services ATS functions.¹³

This IPT established a number of initiatives, including the idea of an architectural approach to test system design and implementation that is now referred to as synthetic instrumentation. This architecture is part of an overall open architecture system that can support new test needs and permit flexible updates and the addition of new technology with minimal impact on existing ATS components.¹⁴

The IPT created a focus group known as the Synthetic Instrument Working Group (SIWG); the SIWG has defined synthetic test systems as follows:

A reconfigurable system that links a series of elemental hardware and software components, with standardized interfaces, to generate signals or make measurements using numeric processing techniques.¹⁵

The goal for ARGCS is to use this type of technology to support both simple and complex system configurations. The flexibility it provides will allow the U.S. Air Force, Army, Marine Corps, and Navy to individually procure systems configured for their specific operational scenarios.¹⁶

This SI software, is what enables the use of legacy TPS without modification. This software can translate “traditional instrument programming statements”¹⁷ to equivalent test and measurement functions of the synthetic system. Demonstrating the ability to preserve TPS software investment more efficiently than previous generations of equipment is one of the major payoffs expected of synthetic test solutions.¹⁸

¹³ RFDesign Website.

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ Ibid.

¹⁸ Ibid.

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III. BCA METHODOLOGY

A. COMPARISON OF APPROACHES

A business case analysis, often referred to as a “Business Plan,” when prepared for private enterprise, is meant to assess the business rationale for choosing or not choosing a particular project and to clarify the parameters and management factors involved in the decision. It is one tool used to evaluate projects.

A BCA in private enterprise is usually an encompassing discussion of the business reasons used to analyze choices. According to Demand Econometrics, “The business case analyzes the current situation, metrics to indicate what's wrong or what needs to be improved, and the underlying reasons why.”¹⁹ The BCA usually includes relevant background information about the problem, as well as a discussion of history, competitive strategy, risk factors, and external market considerations. The purpose is to provide a strategic look at elements that are being considered in making a change in the direction of the business. An analysis of risk is generally a significant feature. A thorough review of the risks of both the status quo and the risks of change is used to provide a more comprehensive discussion of the reasons that a proposed action is being considered.

In the case of OSD, BCAs are used as a tool to support acquisition decisions. The BCA provides the acquiring authority an analysis of quantifiable factors, including costs, and non-quantifiable factors such as the potential joint use. These BCAs tend to include performance, reducibility, reliability, maintainability, and supportability calculations.

A more appropriate comparison of the OSD BCA to a similar civilian tool would be a comparison with a private enterprise Cost Benefit Analysis (CBA). OSD BCAs are generally much less concerned with assessment of strategies than the BCAs in the commercial sector. As referenced earlier, OSD uses the framework they have established

¹⁹ Demand Econometrics Website.

for a BCA to assist in making single program acquisition decisions, not strategic decisions as to the direction of military forces.

A commercial CBA compares what a new item will cost with its expected benefits to the business. Much like the OSD BCA, a commercial CBA is a decision tool used to help answer "should we" and "what if" questions, such as, "should we fund this project?" and "what happens if we do?" A CBA uses tools, like an ROI analysis, to compare the value of investments, particularly, competing projects.²⁰

Both the OSD BCA and commercial CBA are basically an attempt to mathematically quantify the benefits of a particular decision. They both attempt to simulate (model) the expected change brought about by the purchase or acquisition of a particular program or item.

The origin of BCA/CBAs actually lies within the military, in the 1920s, the US Army Corps of Engineers developed a process for economically evaluating which public projects to pursue. Economists formulated the Army's process, and have been formalizing and standardizing CBA methodology since the 1950s.²¹

B. OSD BCA REQUIREMENTS

The basic requirements of defense acquisition focused BCA include:

1. An introduction and definition of the system being analyzed, its purpose and why it is necessary. It should also present the objectives of the system.
2. The methodology and assumptions being used during the analysis including the rationale used in defining the scope of the analysis. A description of the costs and expected benefits over a specified timeframe must be included.
3. The organizational impacts both financial and non-financial associated with the scenarios being compared.
4. If possible a risk assessment should be conducted within the analysis of alternatives.

²⁰ Demand Econometrics Website.

²¹ Ibid.

5. Conclusions and recommendations for specific actions based on the initial objectives of the system being considered
6. The final BCA documents assess the alternatives considered, factors involved, both tangible and intangible and the proposed benefits of the system and a quantification of the return on investment.²²

C. SCOPE OF THIS BCA

Using the guidelines set forth by the DAU, this BCA will meet OSD needs through a comparison of alternatives. In this case, the options are (1) delaying the development of ECASS (until ARGCS can more thoroughly be evaluated) while extending the life of the existing CASS ATE and (2) developing ECASS using the ARGCS technologies and taking the risk that the existing emergent technologies (especially network-enabled maintenance) within the system will develop and become a viable part of the new equipment. The following is an outline of the analysis:

1. A review of the ARGCS system and the objectives associated with its development.
2. A description of the existing alternatives. To be included are the contingencies associated with each option. The focus is on dollar costs associated with existing inventory and sustainment costs versus investment costs and expected savings associated with the new technologies.
3. The methodology and assumptions being used during the analysis including the rationale used in defining the scope of the analysis.
4. An assessment of the expected risks and consequences associated with each alternative.
5. A presentation of the data from the basic qualitative analysis and the quantitative data obtained from the updated Discrete-Event Simulation Model
6. A discussion of the conclusions and recommendations based on the initial objectives of the ARGCS system and the requirements for ECASS.

²² Defense Acquisition University Website.

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IV. ARGCS HISTORY AND TESTING PROTOCOL

A. BACKGROUND

The goal of the ARGCS ACTD is to use emerging test technologies to integrate automatic test system (ATS) hardware and software with a net-centric support system to improve electronic systems maintenance. The goal is for ARGCS to provide diagnostic support at the organizational, intermediate, depot and factory levels of maintenance. ARGCS is intended to be easily and quickly deployable worldwide with reduced airlift and logistics footprint requirements over CASS.²³

B. DEMONSTRATION STRATEGY

The ARGCS ACTD demonstration program has included a Limited Military Utility Assessment (LMUA) conducted with the integrating contractor's (Northrop Grumman) facility and three Joint Military Utility Assessments (JMUAs) conducted at Service maintenance facilities. The JROC selected United States Pacific Command (USPACOM) as the ACTD sponsor, and then they selected the Joint Interoperability Test Command (JITC) to conduct these assessments.²⁴

The LMUA was intended to demonstrate ARGCS capability to provide diagnostic support for all services; to share test and repair data from all levels of maintenance; and to collaborate with other maintenance personnel or SMEs. The JMUA focused specifically on the individual Services and potential ARGCS integration with proposed next generation ATS.

C. ASSESSMENT STRUCTURE

Because ARGCS is not an acquisition program of record, there is not a formal requirements document. Therefore, USPACOM (OSD's designated agent) developed the

²³ "Agile Rapid Global Combat Support System Advanced Concept Technology Demonstration Integrated Assessment Plan" Joint Interoperability Test Command, FT Huachuca, AZ, May 2006.

²⁴ Ibid.

“ARGCS Management Plan” to determine the assessment requirements. This plan is the main focus of the ARGCS IAP and delineates the controls and measures to be used the assessments of the technologies. The plan’s statement of need lists six operational problems that confront the Services in the area of weapons systems support Joint Warfighter Problems (JWP) in the Concept of Operations (CONOPS) developed by the JROC.

Table 1. The Joint Warfighter Problems identified.²⁵

JWP No.	Weapons Systems Support Problem
1	Lack of interoperability between Services' support equipment
2	Support equipment not available for newly fielded weapons systems
3	Support equipment upgrades too slow for weapons systems support
4	High support costs
5	Huge logistics footprint
6	High false failure rates

The next step was to identify the Critical Operational Issues (COI) that relates assessment of ARGCS to the JWPs. In order to resolve the COIs, JITC assigned Measures of Performance (MOP) and suitability (MOS) to identify areas within each COI for assessment.²⁶

To better understand MOPs, start with the overall objective for the ARGCS testing, to determine if the technologies have military usability. Each Service already has an ATS, so in order for ARGCS to have military utility it must improve the status quo. For example, if a metric for improvement is doing the same job faster, a MOP is made that relates to time.²⁷ Specific examples of this follow in the section below.

²⁵ “Agile Rapid Global Combat Support System Advanced Concept Technology Demonstration Integrated Assessment Plan” Joint Interoperability Test Command, FT Huachuca, AZ, May 2006

²⁶ Ibid.

²⁷ Anthony Mason, JITC ARGCS Program Manager, Email June 5, 2007.

MOPs are the evaluation controls for the ARGCS assessment program. MOPs establish the metric (time), what will actually be measured (diagnostic time), and how well the system should perform (i.e., a threshold; such as, 15 percent less than the current standard).²⁸

Other data being gathered during the assessments will be interviews of individual maintainers to identify possible impacts relating to Doctrine, Organization, Training, Material, Leadership, People and Facilities (DOTMLPF).

During each demonstration, maintainers are interviewed with a focus on the following areas:

- Doctrine: procedures for transforming new technologies into joint capabilities
- Organization: how ARGCS technologies enhance mission responsiveness
- Training: skills required to improve individual and unit effectiveness
- Material: equipment needed to support effective use of the ARGCS technologies
- Leadership: whether ARGCS technologies assist in clearing the inevitable fog of war related to equipment maintenance status
- People: appropriate personnel required to operate the ARGCS technologies and their locations
- Facilities: whether ARGCS technologies are capable of operating under the current communications architecture.²⁹

The JITC analysts will validate the DOTMLPF impacts against the ARGCS Concept of Operations. DOTMLPF impacts will be updated throughout the course of the ACTD and will be incorporated into the comprehensive JMUA report at the end of the ARGCS ACTD.

D. METHODOLOGY

The JITC has addressed ARGCS the COIs, MOSs, and MOPs by collecting data in the context of realistic scenarios and real-world missions. To assess the utility of the

²⁸ Anthony Mason, JITC ARGCS Program Manager, Email June 5, 2007.

²⁹ “Agile Rapid Global Combat Support Advanced Concept Technology Demonstration Integrated Assessment Plan” Joint Interoperability Test Command, FT Huachuca, AZ, May 2006.

physical and performance characteristics of the ARGCS Automatic Test System (ATS) it compared to the ATSS currently employed by the Services. Maintainers first diagnosed real problems on their service's legacy test equipment using the selected production TPSs. The maintainers, the TPSs, the faulty unit(s)/component(s), and a fully operational component were then transported to the ARGCS ATS location for diagnoses.

The JITC then developed a functionality and usability survey and administered it at the end of each demonstration to assess maintainer opinions of various aspects of each COI. Each question had a space for maintainers to provide additional comments, explanations, or recommendations. The JITC then validated the survey responses by interviewing respondents before compiling and reporting survey results.³⁰

E. PERSONNEL CONTROLS

In an effort to gauge the usability of ARGCS, average to above average maintainers were requested at NAS Lemoore and other sites. Other than competency on the CASS, the only other criterion for selection as a test participant is if the host feels a particular individual has a voiced interest in the ACTD and wishes to participate.³¹

In addition to participating in the physical assessment of the ACTD, maintainers were interviewed to help identify possible impacts relating to Doctrine, Organization, Training, Material, Leadership, People and Facilities (DOTMLPF).

The JITC analysts then validated the DOTMLPF impacts against the ARGCS Concept of Operations. DOTMLPF impacts were updated throughout the course of the ACTD and then be incorporated into the comprehensive JMUA Assessment Report released in November 2007.³²

³⁰ "Agile Rapid Global Combat Support Advanced Concept Technology Demonstration Integrated Assessment Plan" Joint Interoperability Test Command, FT Huachuca, AZ, May 2006.

³¹ Ibid..

³² Ibid.

F. EQUIPMENT CONTROLS

In conducting JMUA assessments at selected service facilities, it was necessary to use local/legacy ATS equipment as well as current weapons systems. In the case of the Navy this was a standard CASS bench and a unit level F/A-18C. Existing equipment is selected through operational units within an organization that have already agreed to participate in the assessment. In similar fashion to the selection of participating maintainers, organizations (squadrons) are chosen based incumbent leadership interest. The JITC believes this method results in a more realistic test and reduces the number of ambiguities in the final report.³³

G. DATA PROCESSING AND ANALYSIS

Preliminary analysis of the JMUA data is conducted in the field as a further verification of data quality. Anomalies encountered help identify data entry errors. Exhaustive analysis of the data is then being completed at the JITC.³⁴

At the conclusion of each demonstration, JITC conducts an on-site briefing on general impressions. A JITC final report is due 45 working days after completion of last assessment briefing.³⁵

H. EXAMPLE RESULTS TABLES³⁶

The JITC records all test results and summarizes them in tabular form. Because of the detailed nature of the information, a table is placed in an appendix to the assessment report for reference. Table 2 provides an example of how the data is displayed.

³³ Agile Rapid Global Combat Support Advanced Concept Technology Demonstration IAP.

³⁴ Ibid.

³⁵ Ibid.

³⁶ Ibid.

Table 2. Measure of Performance Summary Matrix (Example)

Critical Operational Issue/ Measure of Effectiveness/ Measure of Performance	Threshold	Summary Results			Remarks
		LMUA	JMUA	Total	
CRITICAL OPERATIONAL ISSUE (COI) 1 Does ARGCS provide interoperability between Services’ support equipment (and limited interoperability between each Service’s Organizational, Intermediate and Depot maintenance levels)? (Effectiveness)					
MOE 1.1: The ARGCS is compatible with legacy system test program sets.					
1.1.1 Consolidated Automated Support System (CASS). Percentage of selected CASS test program sets that are ARGCS compatible.	85%	100% (7/7)	100% (1/1)	100% (8/8)	
1.1.2 Integrated Family of Test Equipment (IFTE). Percentage of selected IFTE test program sets that are ARGCS compatible.	85%	80%	80%	80%	Two TPSs not fully compatible.
Legend: ARGCS- Agile Rapid Global Combat Support CASS-Consolidated Automated Support System IFTE-Integrated Family of Test Equipment			JMUA-Joint Military Utility Assessment LMUA-Limited Military Utility Assessment TETS-Third Echelon Test Set		

The JITC assigns a subjective overall rating to each MOP based on a combination of test, survey, and interview results and direct observation. This information is displayed in the main body of the assessment report. Green, Yellow, and Red color codes signify the rating given. The following definitions define the ratings and Table 3 exemplifies the manner in which the ratings are displayed:³⁷

- **Green:** Provides substantial utility. Minor improvements may be needed. Additional data may be required to supplement some findings, but do not affect the overall assessment.

³⁷ Agile Rapid Global Combat Support Advanced Concept Technology Demonstration Integrated Assessment Plan” Joint Interoperability Test Command, FT Huachuca, AZ, May 2006.

- **Yellow:** Provides utility. Improvements may be needed. Additional data may be required in some areas to support a Green assessment.
- **Red:** Provides little or no utility. Major improvements required.

Table 3. MOE/MOS Results (Example)

(i) MOE/MOS	LMUA	JMUA	Overall
MOE 1.1 The ARGCS is compatible with legacy system test program sets.	Green	Green	Green
MOE 1.2 The ARGCS has the capability to share diagnostic information between Services and a Service's maintenance echelons (Levels).	Amber	Amber	Amber
MOE 1.3 The ARGCS is interoperable with components and standard tools within common operating environments.	Green	Green	Green
MOS 2.1 The ARGCS provides accelerated support equipment deployment.	Amber	Green	Green
MOS 3.1 The ARGCS effectively supports diagnostic work.	Green	Green	Green
MOS 4.1 The ARGCS will drive lower lifecycle costs.	Green	Green	Green
MOS 5.1 The ARGCS will reduce the logistical footprint.	Green	Green	Green
MOE 6.1 The ARGCS effectively supports diagnostic work.	Amber	Green	Green
MOS 7.1 The ARGCS is usable by typical operators in the operational environment.	Green	Green	Green
Legend: ARGCS- Agile Rapid Global Combat Support			

I. SUMMARY OF CONTROL SYSTEMS

The IAP states that the purpose of the assessment is to “assess the ARGCS system to determine the extent to which it adds military utility to the Services maintenance operations, methods, or procedures.”³⁸ Based on a review of the plan itself, the goals of management and the controls included within, it appears JITC planned well to this mission.

Control systems in the case of a test and evaluation program are put in place to aid in the acquisition of accurate and usable data. In the case of ARGCS, a very specific and detailed IAP was authored based on successful testing strategies identified by the Joint Forces Command, including an overall management plan. As control systems, this direction is put in place to guide the behavior of individuals responsible for conducting the testing and the analysis of the data gathered. The ARGCS IAP thoroughly ensures that testers and evaluators understand what is expected of them, and that they are aware the goal of an accurate and honest assessment of the technologies. In this case, management control (JITC and USPACOM) have taken the necessary steps to ensure that the testers and evaluators are doing what is best for DoD.³⁹

The overall demonstration methodology develops and excellent test strategy that not only provides an unbiased assessment of the ARGCS technologies but will also appropriately shares the project risk among all the shareholders (DoD, USPACOM, JITC and Northrop Grumman).

³⁸ “Agile Rapid Global Combat Support Advanced Concept Technology Demonstration Integrated Assessment Plan” Joint Interoperability Test Command, FT Huachuca, AZ, May 2006.

³⁹ Merchant, Kenneth A., Van der Stede, Wim A., “Management Control Systems: Performance Measurement, Evaluation and Incentives,” Prentice Hall 2003.

V. ARGCS ECONOMIC ANALYSIS

A. INTRODUCTION

The goal of the ARGCS ACTD is to use new proven technologies such as synthetic instrumentation, open system architecture and an advanced dual core processor to integrate automatic test system (ATS) hardware and software with emergent technologies such as the RMOS and a net-centric support system to provide improved electronic systems maintenance to that currently proved by CASS with a reduced test system footprint.⁴⁰

Specifically, ARGCS open system architecture makes it a flexible system that can be easily reconfigured with advanced technologies and be used as another Service's tester. The net-centric capability is focused on three key areas, overall network infrastructure, common processes, and data management. The network infrastructure is designed to allow an maintainers technical access to the most up to date diagnostic/maintenance data. The common processes involved are focused on providing a systematic approach effectively managing data with ultimate goal of quicker, more accurate, effective diagnostics.⁴¹

If paired with an accessible network the entire ADSR system will enable the reach-back capability that would allow maintainers at the organizational level to capture Weapon Systems Built-in-test (BIT) and other test data, as well as interface with data at the Intermediate and Depot level maintenance echelons. If successful this diagnostic reasoning capability will aid the maintainer in determining which WRA to replace in the case of ambiguous test results. This capability can significantly reduce false pulls and therefore overall maintenance costs. An additional benefit is the ability to include SMEs

⁴⁰ "Agile Rapid Global Combat Support Advanced Concept Technology Demonstration Integrated Assessment Plan" Joint Interoperability Test Command, FT Huachuca, AZ, May 2006.

⁴¹ Ibid.

at the higher echelons during the diagnostic phase providing direct training and an increased learning curve to the inexperienced maintainer.⁴²

ARGCS incorporation of proven state-of-the-art technology has resulted in the ability to significantly reduce the physical size and logistics footprint compared the existing CASS equipment. Additionally, it supports access to electronic and technical orders for maintainers further reducing the overall system footprint by eliminating the need for paper manuals, all resulting in less test equipment to maintain/sustain during deployment/employment operations.

The synthetic instrumentation within ARGCS will allow maintainers to quickly update the system when new capabilities are developed, providing the capability to keep pace with increasing test requirements posed by newer weapons systems. It is a proven technology that is a collection of hardware and software modules that function in the same manner as a standard test instrument, reducing hardware requirements and facilitating the introduction of new test capabilities via software modification vice the replacement of hardware.

B. SYSTEM OBJECTIVES

The main objective for ARGCS is to address a set of significant capability gaps: lack of interoperability of support equipment; delays in fielding capable support equipment for newly fielded systems, difficulties and delays in support equipment upgrades, high support costs; large logistic footprints, and high false failure detection rates.⁴³

ARGCS technologies are intended to provide a set of improved operational capabilities that directly address the identified capability gaps and provide benefits in the following areas.⁴⁴

- More capable and productive test system equipment:

⁴² Agile Rapid Global Combat Support Advanced Concept Technology Demonstration IAP.

⁴³ This list is based on the *Briefing on Agile Rapid Global Combat Support (ARGCS) Business Case Analysis*, April 2006.

⁴⁴ Ibid.

- Resulting from quicker, more accurate fault diagnosis – due to
 - Higher quality data recorded and shared at the various levels (Organizational, Intermediate and Depot);
 - Net-enabled diagnostics based on analysis of relevant maintenance experience and near-real-time access to subject matter experts;
 - Less time to diagnose faults;
- Higher test system reliability and availability due to self-test features, reduced calibration times, and uninterruptible power supplies;
- Leading to leading to fewer test systems required and a corresponding reduction in tester footprint;
- Leading to better transportability for deployed operations due to fewer test systems needed;
- Fewer ATS types in service:
 - Resulting from multiple-weapon system capabilities in one type of test equipment (commonality);
 - Leading to reduced logistics support costs for testers across services and reduced investment costs for the future portfolio of ATSs;
 - Enabling joint and regionalized maintenance;
- Fewer obsolescence problems:
 - Due to system scalability and open architecture;
 - Resulting in quicker, cheaper upgrades and faster fielding of supporting automatic test equipment for new combat systems.

C. IDENTIFICATION OF ALTERNATIVES

Those writing the Request for Proposal (RFP) for ECASS, will need to consider the bundle of technologies currently referred to as ARGCS. Likewise, the RFP will need to consider the advisability of including eventual provision for network-enabled maintenance some time in the future. The alternative is to extend the life of CASS until the networked features of ARGCS have been fully evaluated. A second comparison will be made of not only developing ECASS with all inherent ARGCS technologies but also concurrent development of the network needed to support the net-centric capabilities within the ARGCS system as apposed to just proceeding forward with ECASS as a stand alone tester and delaying the development of the network.

This analysis will perform a comparison of alternatives using current CASS maintenance costs, and the assumed costs of ARGCS enabled ECASS and the supporting network. The analysis will be qualitative in its discussion of the proven ARGCS technologies and quantitative in its use of Return on Investment (ROI) calculations using data from the Franck BCA and the Bello Model to analyze cost comparisons.

D. ASSUMPTIONS AND ESTIMATE OF COSTS

Driving the need for a replacement ATS for the Navy are the desire for reduced test run times and overall reduced costs. The emergent technologies with the ARGCS ACTD answer the need for reduced test run time, in order to evaluate the benefits associated with the ARGCS ACTD as it applies to reduced costs it is necessary to look at the operations and maintenance (O&M) costs for maintaining the current CASS ATS, compared to the expected O&M costs for maintaining ARGCS enabled ECASS plus the costs associated with developing and producing ECASS. Then working in the proposed savings associated with the expected increased capabilities of ECASS using the ARGCS technologies to reduce false pulls and as a result increase F/A-18C operational availability.

The costs associated with CASS (including the expected annual increase in O&M costs) and ECASS, that will be used in the comparisons to follow were obtained from NAVAIR PMA260, they were provided by Mr. Anthony Geneva, the technical manager for the evaluation of the ARGCS ACTD and Mr. Bill Ross, the NAVAIR Deputy Director for Aviation Technology Development (NAVAIR PMA-260D). Previous research (Franck BCA) has estimated the concurrent development of the net-centric capabilities for ARGCS would add approximately \$400M to the developmental costs of the system. Discussions with the previously referenced experts in the field⁴⁵ and, based on CASS Total Ownership Cost experience,⁴⁶ validate this as a realistic figure.

⁴⁵ Source is Dr. Daniel Nussbaum, Professor NPS.

⁴⁶ Source is CASS NAIRTOC report of 26 June 2006.

The goal in making the following to provide ARGCS assessment team with an independent business case assessment of the ACTD's proposed benefits. Due to the fact that ECASS will be a replacement program for the Navy and not one proposed to fill a gap in "warfighter needs", it is necessary to compare expected capabilities and cost to the best available capabilities and costs associated with the existing system, CASS.

Although the RMOS assessment at NAS Lemoore was not conclusive, discussion with experts in NAVAIR indicates that existing RMOSs have been demonstrated to work and therefore the assumption that the RMOS will work as expected will be part of the foundation for our final conclusions.⁴⁷

Although problems currently exist in using the existing networks in the Navy Marine Corps Internet (NMCI) and the Global Combat Support System (GCSS) to enable the reach back capability proposed as part of the net-centric technologies in ARGCS, it will be assumed that such networks will be available with the expected investment cost of \$400M, when comparing that option.

As discussed the ECASS program is intended to replace the CASS, whose embedded technology is several generations old. Current information on CASS indicates that it will rapidly become unsupportable by the Commercial Off the Shelf (COTS) supply chain used to maintain it. As a result, although the networking goal for ARGCS is a valuable goal, the main goal for ECASS is to be the next generation tester not a new network program. It has been stated that "ECASS would not have even left the starting gate if the requirement was to develop a new maintenance network rather than a new tester," so there is a need to develop a separate program for the network elements.⁴⁸

• Cost to produce ECASS/unit	\$2.0M
• Cost to develop ECASS	\$60.0M
• Total ECASS/ARGCS units to be fielded	439
• Annual CASS O&M costs (10% annual increase)	\$53K * 1.10 / year

⁴⁷ Email, Mr. Richard Danz, November, 2007, NAVAIR PMA 260.

⁴⁸Ibid.

- Annual ECASS/ARGCS O&M costs \$53K * .7 / year
- Est. Annual False Pull Savings w/o network \$85M (for 439 units)
- Est. Annual OA Savings w/o network \$65M (for 439 units)
- Est. Annual False Pull Savings w/ network \$110M (for 439 units)
- Est. Annual OA Savings w/ network \$90M (for 439 units)
- Concurrent Development of the Network \$400M

E. IDENTIFICATION OF MISSION RELATED BENEFITS

The proposed mission related benefits for the introduction of ECASS are:⁴⁹

- Interoperability
 - Re-configurable to support multiple weapons systems
- Data Sharing Capability
 - Net centric environment
 - Most up to date data
- Reduced logistical footprint
 - Smaller unit size
 - Fewer spares
 - Less unit maintenance
- Quicker and more accurate fault diagnosis
 - Reduced TPS times
 - Increased accuracy via RMOS
 - Reduced false pulls
 - Reach back access to SMEs
- Faster cheaper capability to upgrade tester capability (synthetic instrumentation)
 - Reduced hardware requirements
- Ease of system upgrades
- Open architecture reduces obsolescence issue in the future

F. ANALYSIS DISCUSSION AND SUMMARY

The ARGCS management plan listed seven Critical Operational Issues (COI) that relate assessment of ARGCS to the JWPs listed earlier, within those COI's measures of

⁴⁹ "Agile Rapid Global Combat Support Advanced Concept Technology Demonstration IAP.

effectiveness (MOE) were established, listed below those MOEs will provide the framework for the discussion on the analysis of alternatives.⁵⁰

COI 1: Interservice interoperability

MOE 1.1: The ARGCS is compatible with legacy system TPS

MOE 1.2: The ARGCS has the capability to share diagnostic information between Navy maintenance echelons.

MOE 1.3: The ARGCS is interoperable with components and standard tools within common operating environments.

COI 2: Faster accommodation of new war-fighting capabilities

MOE 2.1: The ARGCS provides accelerated support equipment deployment.

COI 3: Rapid upgrades to support tomorrow's weapon system performance requirements.

MOE 3.1: The ARGCS technology provides the capability to rapidly upgrade the ATS.

COI 4: Reduction in support costs for maintaining current weapon systems

MOE 4.1: The ARGCS will drive lower life cycle costs.

COI 5: Reduction in logistical footprints (both weight and volume).

MOE 5.1: The ARGCS will reduce the logistical footprint.

COI 6: Reduction in false pulls

MOE 6.1: The ARGCS effectively supports diagnostic work. And reduces unnecessary repair actions (false pulls)

COI 7: Usable by intended users in its operational environment

MOE 7.1: The ARGCS is usable by typical operators in the operational environment.

MOE 7.2: The ARGCS effectively performs self-diagnostics.

The MOEs provide an excellent framework for this discussion. As discussed earlier the new technology within the ARGCS ACTD (dual core processor, open architecture, synthetic instrumentation) are all proven technologies and performed as such during the JMUA assessment in Lemoore.⁵¹ The only portions of the MOEs for the ARGCS ACTD that were not completely validated were those that are directly effected by the RMOS; lower lifecycle costs, smaller logistical footprint and better diagnostics (fewer false pulls). The successful performance of these technologies and the escalating

⁵⁰ "Agile Rapid Global Combat Support Advanced Concept Technology Demonstration Integrated Assessment Plan" Joint Interoperability Test Command, FT Huachuca, AZ, May 2006.

⁵¹ Ibid.

costs to maintain CASS appear to be reason enough, on a qualitative basis, to move forward with the immediate development of ECASS.

If we only look at maintenance and support costs for both systems as a basis for comparison, the quantitative argument is not as strong for the immediate development of ECASS. The Return on Investment (ROI) analysis (Figure 1) indicates an Internal Rate of Return (IRR) of only 1 percent when considering only the O&M savings promised by ECASS. The goal of this comparison was to only look at the savings associated with new equipment. In this case the comparison is made by comparing the escalating costs of maintaining a twenty year old piece of ATE to development and purchase costs of a new piece of ATE and its expected reduction in maintenance costs. This figure is based solely on the purchase and O&M costs of ECASS developed immediately compared to delaying the development for two years and the extended O&M costs of CASS.

A second ROI computation (Figure 2) using these O&M savings in conjunction with the estimated savings due to decreased false pulls (when the RMOS functions effectively) of \$85M and the estimated (Franck BCA) of \$65M due to increases in aircraft operational availability, shows an increase in the IRR to 21 percent, presenting a much more robust quantitative case for the immediate development of the ECASS with the ARGCS technologies.

The third analysis assumes the immediate development of ECASS with the inclusion of all ARGCS technologies plus the immediate development of the support network enabling reachback capability and database updates. This analysis compares the immediate development of the network with waiting five years with the hope of reducing costs. There is reasonably sufficient evidence to support the \$400M price tag (Franck BCA) placed the concurrent development of the associated network, as well as a potential 50 percent reduction in those costs if the development were delayed. In order to make this a realistic comparison a 20 year period was considered. Although in many cases delaying the acquisition of a new system tends to increase overall acquisition costs, in this case it can be expected to reduce them due to the fact that a supporting network isn't currently available but is in development to support other joint net-centric programs. It is very possible that delaying the specific development of a network to support ECASS, can

significantly reduce the amount of money the Navy will spend on the ECASS program if it desires the network to be available when ECASS is deployed. Figure 3 shows that if waiting five years to develop full-up network capability cuts development costs by 50 percent, then there's a good case for waiting, immediate development has an IRR of only 2.7 percent. A sensitivity analysis of the results is shows that if cost were reduced by only a quarter the IRR would jump to 7.4 percent and to 10 percent if the savings were only 10 percent.

REFERENCE POINT IS OPERATING CASS INDEFINITELY										
	1	2	3	4	5	6	7	8	9	
ALT 1										
R&D	5	10	20	15						
ACQ #'S					75	150	150	64		
ACQ \$					150	300	300	128		
O&M	23.267	25.5937	28.15307	30.96838	28.46015	22.2210137	17.15201	16.2869	16.2869	
Total	28.267	35.5937	48.15307	45.96838	253.4602	472.221014	467.152	208.2869	16.2869	1575.389

START DEVELOPING ECASS NOW										
	1	2	3	4	5			8	9	
ALT 2										
R&D	25	25								
ACQ #'S			75	150	150		64			
ACQ \$			150	300	300		128			
O&M	23.267	25.5937	24.0037	20.04862	16.83531	16.2869	16.2869	16.2869	16.2869	
Total	48.267	50.5937	249.0037	470.0486	466.8353	208.2869	16.2869	16.2869	16.2869	1541.896
DELTAS	-20	-15	-200.851	-424.08	-213.375	263.934114	450.8651	192	0	33.4932

ROI(2V1)	1%
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Figure 1. ROI of Retaining CASS indefinitely vs. immediate development of ECASS

REFERENCE POINT IS OPERATING CASS INDEFINITELY					START DEVELOPING ECASS 2 YEARS IN FUTURE.					
	1	2	3	4	5	6	7	8	9	
ALT 1										
R&D	5	10	20	15						
ACQ #S					75	150	150	64		
Operational Availability					-11.104784	-33.3143508	-55.523918	-65	-65	
False Pull Savings					-14.52164	-436.6173121	-72.6082	-85	-85	
ACQ \$					150	300	300	128		
O&M	23.267	25.5937	28.15307	30.968377	28.460152	22.22101373	17.15201	16.2869	16.2869	
Total	28.267	35.5937	48.15307	45.968377	227.83373	2.289350861	339.01989	58.2869	-133.7131	651.69892

					START DEVELOPING ECASS NOW					
ALT 2	1	2	3	4	5	6	7	8	9	
R&D	25	25								
ACQ #S			75	150	150	64				
OA Savings			-11.104784	-33.314351	-55.523918	-65	-65	-65	-65	
False Pull Savings			-14.52164	-436.61731	-72.6082	-85	-85	-85	-85	
ACQ \$			150	300	300	128				
O&M	23.267	25.5937	24.0037	20.04862	16.835306	16.2869	16.2869	16.2869	16.2869	
Total	48.267	50.5937	223.37728	0.1169574	338.70319	58.2869	-133.7131	-133.7131	-133.7131	318.20572
DELTAS	-20	-15	-175.22421	45.85142	-110.86946	-55.99754914	472.73299	192	0	333.4932

ROI(2V1)	21%
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Figure 2. ROI of delaying ECASS development for two years vs. immediate development

REFERENCE POINT IS IMMEDIATE DEVELOPMENT OF THE NETWORK

ALT 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Investment in Network	50	50	100	200																
R&D	25	25																		
ACQ #'S			75	150	150	64														
OA Savings			-15.4	-46.13	-76.9	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90
False Pull Savings			-18.8	-565	-94	-110	-110	-110	-110	-110	-110	-110	-110	-110	-110	-110	-110	-110	-110	-110
ACQ \$			150	300	300	128														
O&M	23.26	25.6	24	20	16.8	16.3	16.3	16.3	16.3	16	16.3	16.3	16.3	16.3	16.3	16.3	16	16.3	16.3	16
Total	98.26	100.6	315	58.84	296	8.3	-184	-183.7	-184	-184	-184	-184	-184	-184	-184	-184	-184	-184	-184	-184

ECASS
ONLY

ALT 2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
R&D	25	25																		
ACQ #'S			75	150	150	64														
OA Savings			-11.1	-33.31	-55.5	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65
False Pull Savings			-14.5	-436.6	-72.6	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85
ACQ \$			150	300	300	128														
O&M	23.26	25.6	24	20	16.8	16.3	16.3	16.3	16.3	16	16.3	16.3	16.3	16.3	16.3	16.3	16	16.3	16.3	16
Total	48.26	50.6	223	0.068	338.7	58.3	-134	-133.7	-134	-134	-134	-134	-134	-134	-134	-134	-134	-134	-134	-134
DELTAS	50	50	91.5	58.77	-42.7	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
ROI(2V1)	14%																			

Figure 3. Wait five years to develop full network capabilities to reduce costs.

VI. CONCLUSION AND RECOMMENDATION

Current projections indicate that the O&M costs for CASS will continue to grow in the near future (minimum 10 percent/year), but the business case for moving forward quickly with ECASS incorporating ARGCS technologies (based solely on O&M costs) is not particularly robust. However, if estimated savings gained from increased F/A-18C operational availability and estimated savings from fewer false pulls are also included, the IRR jumps to 21 percent for the standalone ARGCS-enabled ECASS unit. Currently in the commercial sector an ROI evaluation that yields a return greater than 7 percent is considered significant, however in this case since the primary goal for ECASS is to be a smaller less costly replacement for CASS with the capability to be easily upgraded, a goal which previous discussion shows that it meets, any IRR that is not a cost (a negative) is to be considered to have met the analysis “hurdle percent”.

Additionally, even if we avoid any speculation and strictly focus on the proven technology within the ARGCS ACTD, that would be a significant portion of the ECASS tester, the case to move forward is quite strong. The significant portions of the ACTD, such as the dual-core processor, open system architecture and synthetic instrumentation all work. The JMUA in Lemoore proved that the ARGCS ACTD works as well as the current state CASS as a tester and that the piece that kept the ACTD from performing diagnostics faster was the existing TPS. If the decision to proceed with ECASS/ARGCS is made, TPS hardware and software will be developed to augment the added speed and capability included in the unit.

A. SUMMARY OF BENEFITS

1. Proven

- Interoperability through the use of Open System Architecture
- Reduced logistic footprint
- Quick and accurate fault diagnosis
- Synthetic Instrumentation Capability

2. Expected

- Net-Centric Diagnostics and better diagnostics will lead to less false pull rates and a reduction in the number of weapon system spares needed

NAVAIR has indicated that RMOSs have worked elsewhere and that any help from an operational reasoner will be a significant upgrade, therefore not proceeding due to the inconclusive results of the RMOS performance at the JMUA would be not be advisable.

Additionally, the Navy should recognize that a strong case can be made for including provisions for future network capability when developing ECASS. Although a strong case can be made for developing the network now, if significant savings can be achieved by waiting, and still having the network available when ECASS starts Limited Rate Initial Production (LRIP) there would be a significant increase in ROI. Also, it needs to be noted that developing the network was not part of the ARGCS IAP, and even if the network development is delayed indefinitely ECASS should still be developed with that ability in order to make full use of the network capability when it does become available.

Although the estimated costs for producing ECASS are likely accurate, acquisition programs have a history of going over budget; if there are program budget cuts are for this reason, program managers should be advised not to make those cuts in the net-centric features of ECASS. Although ECASS will perform well as a tester, a significant capability leading to significant future savings could well be lost. That the ECASS is being developed primarily as a standalone test system should not be reason to ignore the advantages of network capability. Doing so would be analogous to building a computer without an internet hookup, just because the internet is not yet fully operational.

The Bello Discrete-Event model and the Franck BCA also indicate there will be significant false pulls savings with a standard ECASS and operating RMOS. The results of the simulation indicate that the reasoners ability to resolve ambiguous tests could

result in up to a 50 percent reduction in false pulls and 30 percent increase in aircraft operational availability, saving over \$65M and \$85M respectively, throughout the Naval Aviation.

The model also indicated that the proposed improved capability with the ARGCS system to reduce TPS run times by 15 percent would result in a 3 percent reduction in spares required. Since an O-level organizations will always carry as many spares as it has room for, the savings in this case manifest themselves in carrying a higher percentage of spares for the WRAs that fail more frequently. As the RMOS builds its database, in addition to helping solve ambiguous test results, it also designates the percentage of time a particular WRA fails in proportion to the others being analyzed in a particular TPS. This information can be used to equip maintenance organizations with a more appropriate spare parts mix, as well as identify those WRAs that need mean time to failure improvements. It may also result in a smaller footprint of WRAs at all levels in the future.

Based on a significant IRR and potentially better operational availability and false pull rates, significant consideration should be given to concurrent development of the network with ECASS.

In assessing the current state of CASS and its escalating O&M costs, the positive IRR of replacing CASS with ECASS and the successful performance of ARGCS as a WRA tester, it appears that a solid business case exists for moving forward quickly with development of ECASS.

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